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ABSTRACT

This paper describes a model for the systematic design, development, and validation of alternative instructional modules, by incorporating the basic concepts underlying Aptitude Treatment Interaction (ATI) analyses. The proposed working model is based on the premise that the ATI concept is best applied, not in isolation, but as an integral part of a dynamic decision-making instructional environment. Four areas of interest in the application of the ATI concept in an operational environment are discussed: (1) operational methodology, (2) variable categories, (3) statistical procedures, and (4) alternative module development guidelines. (Author)

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APPLYING THE ATI CONCEPT IN AN OPERATIONAL ENVIRONMENT

by

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APPLYING THE ATI CONCEPT IN AN OPERATIONAL ENVIRONMENT

Overview

For many years, much has been written about ATI methodology, ordinal and disordinal interactions, and the search for meaningful hypotheses involved with ATI research. In this brief paper, the writer has attempted to synthesize both prior work experience and prior readings into a working model. This model attempts to set forth a framework for designing alternative instructional modules that have rewards for both the learner and instructor.

By way of review an aptitude variable can be any personological or organismic variable upon which individuals differ (e.g. IQ, anxiety, dogmatism, level of prior experience with subject matter, etc.). A treatment is any instructional strategy or combination of instructional strategies that structures information for the purpose of having students learn that information. As generally defined, an aptitude-treatment-interaction exists when, as a result of a given treatment, individuals at one end of an aptitude variable perform at one level on a criterion measure. Individuals at the other end of the aptitude variable perform at a significantly different level on the criterion measure and the reverse trend holds true for a second treatment. In the hypothetical situation illustrated, clearly Treatment #1 would be desirable for high aptitude learners and Treatment #2 would be desirable for low aptitude learners. (For an expanded discussion, see Snow and Salomon, 1968; Bracht, 1970; Rhetts, 1974; Snow, 1977; Cronbach and Snow, 1977.)

The literature is filled with plots (varying greatly in degree of angularity) of different treatment groups against both aptitude and criterion measures. However, little if anything is written which proposes how to incorporate the ATI concept into a decision making instructional environment. Two common criticisms of the ATI approach are that generalizations resulting from ATI research: (1) lack a design strategy that demonstrates a need to develop alternative modules in the first place; and/or (2) These generalizations are not easily interpreted so as to provide detailed guidelines for instructional designers. The proposed working model is based on the premise that the ATI concept is best applied, not in isolation, but as an integral part of the dynamic decision making instructional environment.

Four areas of consideration, for applying the ATI concept in an operational environment, will be presented: (1) Operational Methodology (overall master plan) (2) Variable Categories (for independent and dependent variables), (3) Statistical Procedures (analyzing the results), and (4) Alternative Module Development Guidelines (detailed guidelines for instructional designers).

Operational Methodology

Underlying the implementation of this model is the assumption that for most of us, the time and expense involved in alternative module development is not worth taking unless the existing instructional module causes large or alarming variations in the criterion variable. That is, if everyone is reaching criterion or achieves mastery (passing grade) in an acceptable time frame within a given module, why use resources searching for ATI's or developing alternate modules? It is only when grades, time to completion, or some other dependent variable of interest and importance varies within a given module, that educators should be concerned about developing alternate modules. Only then does it seem justifiable to allocate resources for alternative module development.

The operational methodology suggested here involves five main steps (refer to Figure 1):

Step 1: (Point "A") Establish Main Track Module(s)

Establish a single or main track of instruction; that is, develop a "best guess" approach by designing one module per instructional concept for the entire unit or course being taught.

Step 2: (Point "B") Establish Data Analysis Pool

Establish a data pool of variables of interest and importance. These variables must be ones that are expected to be closely associated with performance on the criterion measure.

Step 3: (Point "C") Assess Variance

Examine the dependent variable of interest, usually time or score, with regard to amount of variance in main track instruction. Identify main track modules with unacceptable variance in the dependent variable.

Step 4: (Points "D" and "E") Analyze Data

Analyze data and, based on significant predictor set(s), develop alternative modules for main track modules, only where large variations exist in the dependent variable.

Step 5: (Points "F" and "G") Validate Alternative Module(s)

Validate alternative module development. Examine actual performance data associated with predicted performance data under varying module assignment rules; i.e., random vs. non-random for both main track and alternative module(s). Assess results and make decision(s).

Variable Categories

Once the main track module(s) have been developed (Step 1), serious consideration must be given to the selection of variables to be entered into the data pool. At least four categories of independent variables are suggested for consideration during Step 2 (Figure 1, Point "B"):

1. Cognitive
2. Achievement Motivation
3. Personality/Anxiety
4. Derived

COGNITIVE - This would be either a general mental ability measure or an aspect of general mental ability for which a strong rationale could be built that this aspect is related to performance on the dependent variable (e.g. high spatial ability skills required: measured by performance on a visual discrimination test).

ACHIEVEMENT MOTIVATION - This element of the data pool is extremely important in determining the degree to which an individual's motivation to succeed is related to the task at hand. This variable must be designed to measure specific task achievement motivation for the dependent variable of interest (e.g. high success drive required: measured by performance on a test to identify potential corporate executives). For an excellent discussion of factors to consider in the selection of this type of variable, see deCHARMS and MUIR (1978).

PERSONALITY/ANXIETY - According to Cronbach and Snow (1977) analysis of achievement via levels of anxiety is a potentially useful concept that has emerged from analyzing many ATI studies. The optimal level between anxiety and various levels of state/trait curiosity as predictors for differing kinds of performance tasks has yet to be widely studied, much less reported in detail. Among those who have written on this topic are: Leherissey, O'Neil, and Hansen (1972 and 1973); Spielberger (1972); and McCombs (in press).

DERIVED - A fourth category of independent variable that may deserve attention in more sophisticated instructional environments is a category often called a "within-course" or "derived" variable. It is simply using time on one module (or some other variable whose value is not determined until after the start of an instructional unit) to predict time/score (or some other dependent variable of interest) on subsequent modules. This set of variables is often only able to be studied in very sophisticated computer managed systems where dynamic decision-making and data collection are possible.

Dependent variable(s) must also be selected. These are usually either time to completion, number of trials to completion, total score, or some combination of all three.

Statistical Procedures

There are basically two stages in the data analysis procedures. They involve:

1. Identifying the main track modules with large variations in the dependent variable (Figure 1, Point "C").
2. Using stepwise multiple regression to identify a predictor set that is predictive of dependent variable values (Figure 1, Point "D").

ASSESSING VARIATIONS - Admittedly identifying main track module(s) with excessive variations in the dependent variable is often an arbitrary decision. There are many sophisticated statistical techniques to determine empirically what constitutes large or significant. However, the emphasis here is on presenting a model or procedure that stresses operational considerations.

Preliminary examination simply of range, standard deviation and mean score for each main track instructional module dependent variable can provide a wealth of usable information. Each educator must then make some hard decisions about what is

acceptable performance variability. When modules have unacceptable or large variations in performance, they then become candidates for further and more discriminating statistical analysis. Where large variations in main track modules do not exist, it only makes good sense to either continue using that module or make minor revisions and repeat the analysis process.

DETERMINING PREDICTOR(S) - Once a module has been identified as having unacceptable variations in the dependent variable (that is, some sub-group of students performed well or quickly while another sub-group of students performed poor or slowly), the task of determining the best predictors of performance begins.

The analysis procedure suggested here is to use stepwise multiple regression to identify, from the previously obtained data analysis pool, significant predictor set(s) for the performance variable. By examining the complex nature of significant predictors, a more accurate estimate of those variables specifically associated with performance by a sub-group of students, when attempting a given task, is possible. Lacking a theoretical framework for the selection of variables to be entered into the analysis pool would be a major deficiency in the implementation of the procedures suggested here.

Alternative Module Development Guidelines

Once the predictor set is identified, alternative module development begins (Figure 1, Point "E"). For illustration, assume the following hypothetical situation exists when attempting to predict a score on a particular main track module.

Predictors	Simple r	Mult R	R^2
Curiosity	+.40	.40	.16
Spatial Ability	+.38	.56	.31
Verbal Reasoning	-.35	.72	.52

In this situation, we see that curiosity and spatial ability are positively related to performance while verbal reasoning is negatively related; also, 52 percent of the variance in the dependent variable is accounted for by combining all three independent variables as predictors. One instructional strategy that might be worth pursuing would involve building an alternative module that aroused curiosity while compensating for lack of spatial ability. This alternative module would be hypothesized to be appropriate only for low verbal reasoners. Such a module might have advanced organizers that demonstrate how the material being presented is related to future job skills or arouse curiosity. The instructional content would then use few or relatively simple visuals (compensate for spatial ability). Again, this module would be designed solely for low verbal reasoners.

The above instructional strategy is not conclusive. However, it is a researchable strategy that is meant to be (1) empirically derived and (2) based on a rationale to facilitate learning for a group of students who might be able to profit from some kind of alternative module.

During the alternative module validation phase, regression analyses would be run, against the criterion, on various combinations of main track and alternative modules which had been assigned to (1) all students, (2) predetermined sub-groups of students, and (3) random sub-groups of students. By comparing these regression slopes, and weighing the cost involved in alternative module development against the payoff derived, decisions could be made about whether to continue alternative module implementation or continue with main track materials only (see Figure 1, Points "F" and "G").

If the validation phase bears out the proposed hypothesis, then the alternative module would be assigned to this sub-group of students as the "primary" module at the start of the instructional unit. It is in this area of module assignment, module accounting, and record keeping that computer managed systems are most valuable.

Summary

The above procedure is an attempt to synthesize some of the recent thinking about ATI studies and alternative instructional module development. After all, ATI analyses and resulting alternatives are neither always appropriate nor cost effective and should be viewed as part of a larger picture. That is, they should be viewed as part of an empirically based decision model for alternative instructional module development.

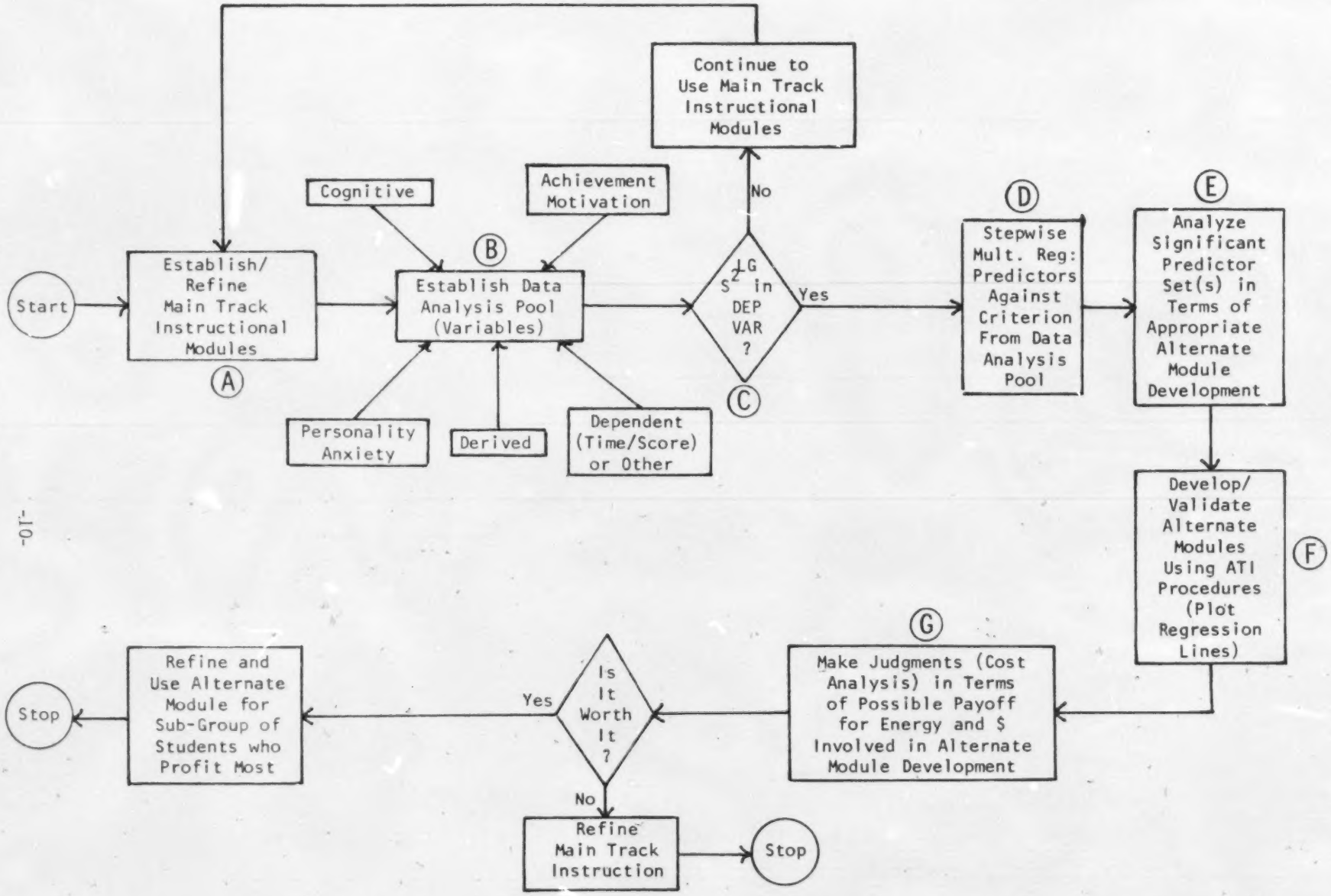

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Figure 1 - A Data Based Procedure for Developing Alternative Instructional Modules

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